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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003905259 for a patent by GRADEN INDUSTRIES PTY LTD as filed on 26 September 2003.

WITNESS my hand this
Eighth day of October 2004

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AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Applicant:

GRADEN INDUSTRIES PTY LTD

Invention Title:

SCARIFIER

The invention is described in the following statement:

SCARIFIER

The present invention relates to a tractor mounted scarifier and a pedestrian scarifier used for cutting turf surfaces.

It is widely recognised that rigorous turf maintenance practices are essential in maintaining healthy growing turf surfaces. Such practices as aerification, topdressing, verticutting and dethatching are particularly important in maintaining good sports surfaces such as for golf greens or cricket pitches.

Organic matter in the form of old roots and other plant matter accumulates in the upper portion of the soil profile. This accumulation can alter the balance of pore space which in turn reduces the rate of soil oxygenation and results in an inferior turf surface. Managing the physical properties of the soil in the upper portion of the soil profile is essential in maintaining healthy grass. Dethatching by verticutting physically removes organic matter by using a blade to cut a path into the surface profile to bring organic matter to the surface and to aerate the ground. The process usually also includes topdressing the soil after dethatching.

A scarifier physically removes organic matter by dethatching. One type of scarifier is a verticutter having spaced circular blades that rotate to cut grooves in the turf as the scarifier machine moves forward. The blades rotate to raise thatch, stolons and other organic materials in the machine's wake. The blades can either rotate or counter-rotate to the direction of the moving scarifier. The resulting grooves open up the turf for top dressing, seeding or other operations. The grooves also

allow better water and air exchange in the turf soil surface.

After drawing the accumulated organic matter to the surface of the turf, the matter is removed by using shovels, rakes, larger shoveling machines and/or blowers. The grooves can then be filled with top dressing in the form of sand or seeding materials.

While this maintenance process is effective in maintaining good health of the grass layer the process is time consuming. Additionally, a playing green is put out of use for the time it takes to aerificate, dethatch and topdress the green. The green is also usually unable to be used for part of the recovery process thereafter, which takes up to two weeks.

A more efficient and easier to use scarifier is required for aerificating turf.

In one embodiment the invention provides a scarifier for cutting turf comprising an elongate frame supported on wheels, a plurality of circular cutting blades coaxially mounted on a rotor shaft supported by the frame, driving means to drive the rotor shaft and rotate the blades, and adjustment means for simultaneously adjusting the position of each wheel relative to the frame thereby adjusting the height of the rotor shaft off the ground.

The wheels are preferably co-dependently attached to the frame by a linkage operable from a control point. The control point is preferable a handle screw threaded in a boss and rotatable in the boss against a reaction surface wherein the boss is fixed to the linkage.

The linkage preferable comprises: a pivot bar extending across the frame and journalled thereto at its

end, the boss being fixed to the pivot bar; a first curved arm attached at one end to the pivot bar and at the other end to a wheel; and a linking member connected at one end to pivot with the pivot bar and at the other end to pivot with a second curved arm which supports a second wheel, so that the vertical positioning of the first and second wheels are simultaneously adjusted.

There are preferably two pairs of front and rear wheels, each pair being supported by curved arms where the curved arms are linked by a linking member pivotally attached to the pivot bar, and wherein one wheel is fixedly attached to the pivot bar.

There are preferably two handles both connected to the pivot bar together are capable of adjusting the positioning of all linked wheels.

The drive means preferably comprises a belt drive driven by pulley shafts that are powered through a gear box by a drive shaft.

The scarifier is preferably connectable to a tractor having a motor thereon to drive the drive shaft.

In a further embodiment the invention provides a scarifier for cutting turf comprising a frame mounted on wheels, a plurality of circular cutting blades coaxially mounted on a rotor shaft supported by the frame in an elongate rotor housing, the rotor housing being independently movable relative to the frame, driving means to drive the rotor shaft and rotate the blades, and adjustment means for adjusting the height of the rotor housing relative to the frame.

The drive means preferably includes two belt drives connected in series having in common an intermediate

pulley mounted on an intermediate shaft, wherein the rotor housing is pivoted at the intermediate shaft to move relative to the frame.

The movement of the rotor housing is preferably actuated by an operating lever connected to the housing through a linkage.

Preferably, the rotor housing is supported at its ends by rotor wheels. The rotor wheels are pivotally mounted on a wheel shaft to the rotor housing such that the wheels move relative to the rotor housing to adjust the change in cutting depth of the blades.

The scarifier is preferably mounted on four support wheels. It preferably has a motor that drives the blades and the support wheels, and a drive lever is operable to hydrostatically drive one or more support wheels at variable speeds.

In this embodiment the scarifier is a pedestrian controlled scarifier and has a handle extending diagonally upward to steer the scarifier. The handle supports the operating and drive levers.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention are described further by way of example with reference to the accompanying drawings of which:

Figure 1 is a perspective view of a tractor mounted scarifier according to the present invention with the covers removed;

Figure 2 is a closer perspective view of the wheel adjustment mechanism of the scarifier of Figure 1;

Figure 3 is a sectional side view of a pedestrian scarifier with the rotor housing in the raised position;

Figure 4 is a similar view to Figure 3 but with the rotor housing in the lowered position; and

Figure 5 is a side view of the pedestrian scarifier.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings illustrate two types of scarifiers, namely a tractor mounted scarifier 10 and a pedestrian scarifier 20.

The tractor mounted scarifier 10 is illustrated in Figures 1 and 2 and has an elongate frame 11 constructed in welded steel, a housing 12 to house the operating components of the scarifier, and internal components all of which are mounted on four wheels 13. Scarifier 10 is mounted to the rear of a tractor by conventional hitching means. The scarifier is PTO (Power take-off) powered by the tractor through a drive shaft (not shown) that couples with a gear box 14 mounted on the scarifier frame 11.

As illustrated in Figure 1 gear box 14 drives two opposing pulley shafts 15 that extend from opposite sides of the gear box to the far ends of the scarifier frame 11. The pulley shafts 15 are supported in recesses 30 at the far ends of frame 11. Pulley wheels 16 attached at the end of each pulley shaft 15 drives a rotor shaft 18 by way of belt 17. Rotor shaft 18 extends along the underside of scarifier 10 and is driven at both ends by the pulley and belt arrangements. A number of spaced circular blades (not shown) are mounted on rotor shaft 18. The blades rotate vertically about the horizontal rotor shaft to produce a vertical cut groove in the turf.

In this embodiment the blades are 210mm inch diameter hardened blades with a 30mm spacing between each blade. The preferred blades are quite thin, at 2mm, to avoid leaving large grooves in the turf. However, 1mm and 3mm thick blades can also be usefully employed.

The cutting depth of the blades can be adjusted by adjusting the relative height of the wheels 13 to the frame 11. The depth of the cut generally ranges between 0 and 45mm.

All four wheels are interlinked by an adjustment linkage mechanism 31 that provides for mutual raising and lowering of all four wheels 13 from one or two control points. The control points are namely adjusting handles 32. The adjustment mechanism 31 is illustrated more closely in Figure 2.

A trailing pivot shaft 33 is rotatably mounted at its ends to fixed cross bars 34 which are fixed to frame 11. A pair of front and rear wheels 13a and 13b respectively are operably connected through a linkage system to each end of pivot shaft 33.

The two adjusting handles 32 are each provided with an externally threaded shaft 35 which turns in a bore 36 having a corresponding inner thread. Bore 36 is securely attached to pivot shaft 33 through connecting piece 37 such that bore 36 moves with and around pivot shaft 33. A reaction plate 40 adjacent bore 36 provides a reaction surface for the threaded shaft 35 when it extends through to the other side of bore 36.

The weight of the wheels and of the linkage mechanism 31 is such that the end of threaded shaft 35 protruding through bore 36 is usually in abutment with plate 40. A curved "S" shaped rear arm 41 is fixedly mounted near each

end of pivot shaft 33 and extends rearwardly. Each rear arm 41 supports at its end a rear wheel 13b. Therefore, as the handles 32 are rotated against plate 40, bore 36 moves up or down threaded shaft 35 of each handle to rotate pivot shaft 33 and directly raise or lower the rear wheels 13b.

In the preferred embodiment, two handles are dependently used for lowering the wheels so as to avoid twisting and warping of the pivot shaft 33. However, it is possible to construct the scarifier with only one operating handle. This would be achieved by, for example, forming pivoting shaft 33 from a thicker gauge metal to give it more strength.

Rotating handle 32 illustrated in Figure 2, for example, in the clockwise direction will move bore 36 away from the reaction plate 40 thereby pivoting pivot shaft 33 to lower rear wheels 13b relative to the frame 11. In the preferred embodiment, both handles are simultaneously rotated, or alternately rotated in increments, to lower the wheels. Fine adjustment in levelling the blades to the ground requires independent adjustment of the handles.

The relative height of each front wheel 13a is simultaneously adjusted with the movement of the corresponding rear wheel 13b. A linkage arm 42 is pivotally attached to an enlarged segment 43 at an upper end of rear arm 41 defining one end of the "S" shape. Linkage arm 42 extends from the rear of the scarifier 10 parallel with crossbar 34 to the front of the scarifier 10 to be pivotally connected at its other end to a roughly "C" shaped curved front pivoting arm 44. Linkage arm 42 is pivotally mounted at an end of the "C"-shaped front arm. The other end of the front arm 44 provides a hub support for the front wheel 13a.

Spaced a short distance from the pivot connection with linkage arm 42 on front arm 44 is a pivot pin 45 pivotally securing front arm 44 to fixed crossed bar 34.

The above arrangement of linking front wheel 13a to the rear arm 41 allows simultaneous lowering of both the front and rear wheels. For example, rotating handle 32 in a clockwise direction as illustrated in Figure 2 will cause curved rear arm 41 to pivot at its connection with pivot shaft 33 to lower rear wheel 13b. This movement by way of the attachment of linkage arm 42 with the enlarged segment 43 draws linkage arm 42 rearward. This in turn causes front arm 44 to pivot about fixed pivot pin 45 (in the counter-clockwise direction as illustrated in Figure 2) to lower front wheel 13a.

The same linkage operation occurs in the mirror image at the other end of pivot shaft 33 with the pair of front and rear wheels not shown in Figure 2.

In the preferred embodiment both handles 32 are used to evenly control the height of the blades and thereby the cutting depth. Once the depth appears to be level, small adjustments can be independently made on each handle to correct any minor misalignments, thereby ensuring an even cutting depth across the width of the machine.

Accordingly, the effective height of the frame 11, and hence the cutting blades, relative to the wheel can be adjusted by simply a turn of the handles.

As mentioned earlier, it is possible to construct the machine with only one handle operating the pivot shaft, but this would require compensatory changes to the construction and strength of the linkage mechanism of the scarifier in order to avoid twisting and damage to the pivot shaft 33. For example, one handle would be

sufficient where the pivoting shaft is shorter than that illustrated herein or where the pivoting shaft is made from a thicker gauge metal.

The scarifier illustrated in the drawings shows the gear box mounted off-centre on the frame. This can create a weight imbalance which can impact scarifier performance. Counterweights can be attached to the frame to counterbalance the weight of the gear box.

A pedestrian scarifier is illustrated in Figures 3 to 5 and operates in a substantially similar manner to the tractor mounted scarifier but the difference being that the driving means is a two-stroke or a four-stroke engine similar to that of a motor mower, mounted onto the scarifier itself.

In known pedestrian scarifiers the cutting depth is adjusted by raising and lowering the entire machine relative to the wheels. With the present pedestrian scarifier only the rotor housing 21 is lowered.

The pedestrian scarifier has a frame 51 mounted on four wheels 56. Extending diagonally upward from frame 51 is a handle 54 to push the pedestrian scarifier. The rotor housing 21 is pivotally mounted on the scarifier frame 51. As illustrated in Figure 5, rotor wheels 55 are mounted at the sides of the rotor housing to provide support to the blades during operation. Rotor wheels 55 are pivotable on wheel shaft 53 relative to the rotor housing 21 to enable the cutting depth to be adjusted.

The degree of pivot of rotor wheels 55, and therefore blades 50, about wheel shaft 53 is variable so that the cut depth can be adjusted as desired. Once the desired depth is set the rotor wheels are locked into place. The wheel shaft 53 extends through to the other side of the

rotor housing connecting a mirror image linkage to the rotor wheel and housing at the other side of the rotor housing to that illustrated in Figure 5.

A motor driven shaft 22 drives first belt 23 to drive intermediate shaft 24 which in turn drives rotor shaft 25 by way of a second belt 26. A series of circular rotor blades 50 are mounted on rotor shaft 25.

The rotor housing 21 is mounted on scarifier frame 51 to pivot about intermediate shaft 24. A control linkage 27 mounted to the frame 51 controls the raising and lowering movement of rotor housing 21, with the movement being controlled by lever 52 on the handle 54 of scarifier 20.

To illustrate this, Figure 3 shows rotor housing 21 in the raised position adopted when transporting or turning the scarifier. Pushing lever 52 downward causes the control linkage 27 to lower rotor housing 21 into the lowered position illustrated in Figure 4 used when operating the scarifier.

By locating the pivot point of rotor housing 21 about intermediate shaft 24 belt tension can be constantly maintained while raising and lowering the blades. Furthermore, slippage on the belt and loss of drive to the blades avoided.

The rotor wheels are in line with the rotor shaft and therefore move in unison with the blades. This enables a constant depth of cut over any type of surface, and even on undulating surfaces the rotor housing moves with the rotor wheels 55 to match the blade cuts on the undulating surface.

A drive lever (not shown) incorporated into the handle 54 uses a hydrostatic drive to drive the driving wheels of the pedestrian scarifier at variable speeds.

In both the tractor mounted and pedestrian scarifiers the blades are arranged such that the blade tips are out of phase with the blade tips on each adjacent side. This means that during operation the blade tips cut into the turf in sequence.

Both embodiments illustrate a scarifier mounted on four wheels. However, it is understood that more or less wheels could be effectively used with some minor alterations to the frame and/or linkages.

The present scarifiers enable easy adjustment of the cutting depth using minimal adjustment controls and without the need for any adjusting tools. The scarifiers, whether tractor mounted or pushed, enjoy smooth and controlled scarifying of turf at constant depths.

It will be understood to persons skilled in the art of the invention that many modifications may be made without departing from the spirit and scope of the invention.

GBS-1200
Verticutter/Scarifier
(Covers removed)

FIGURE 1

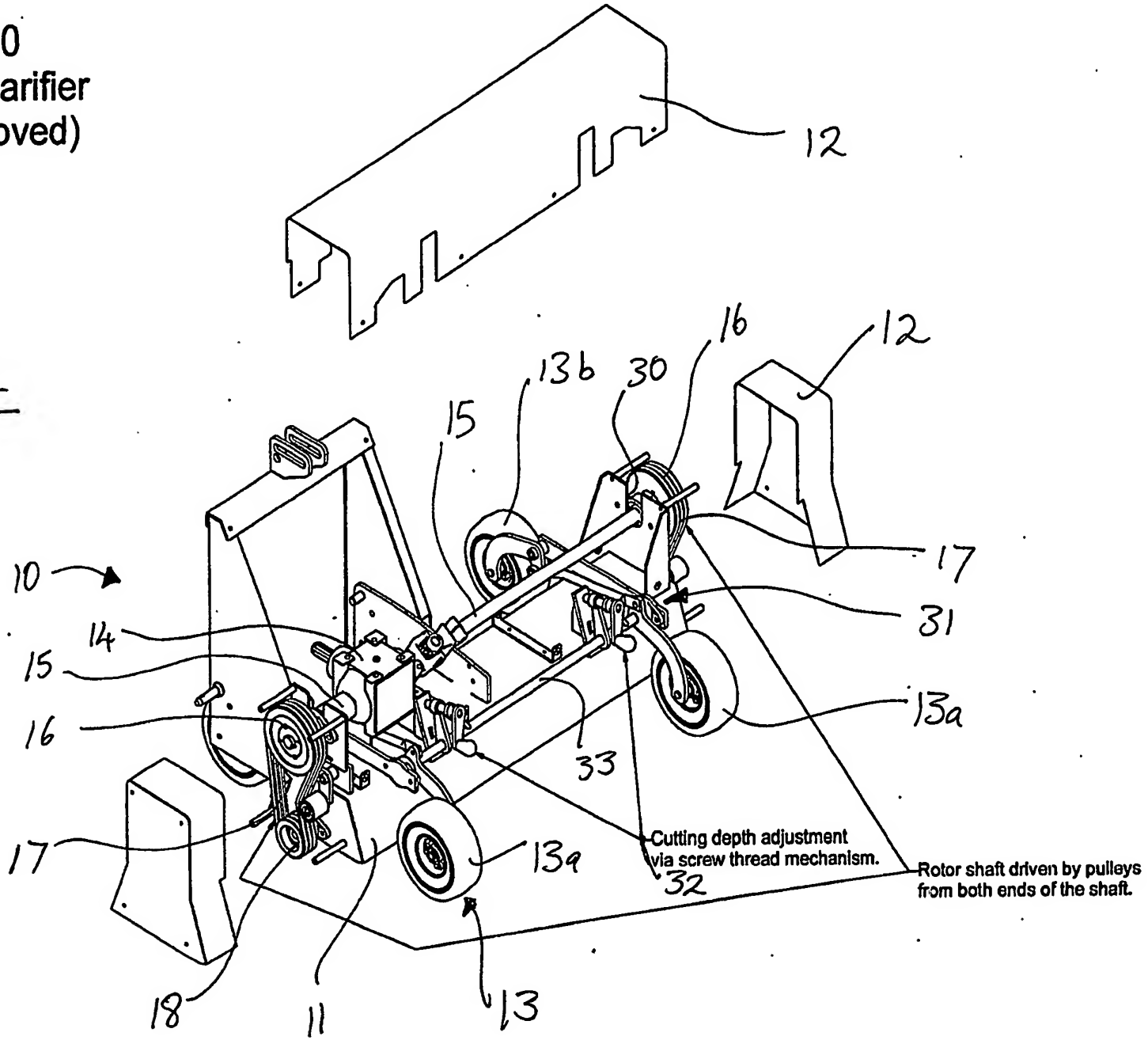
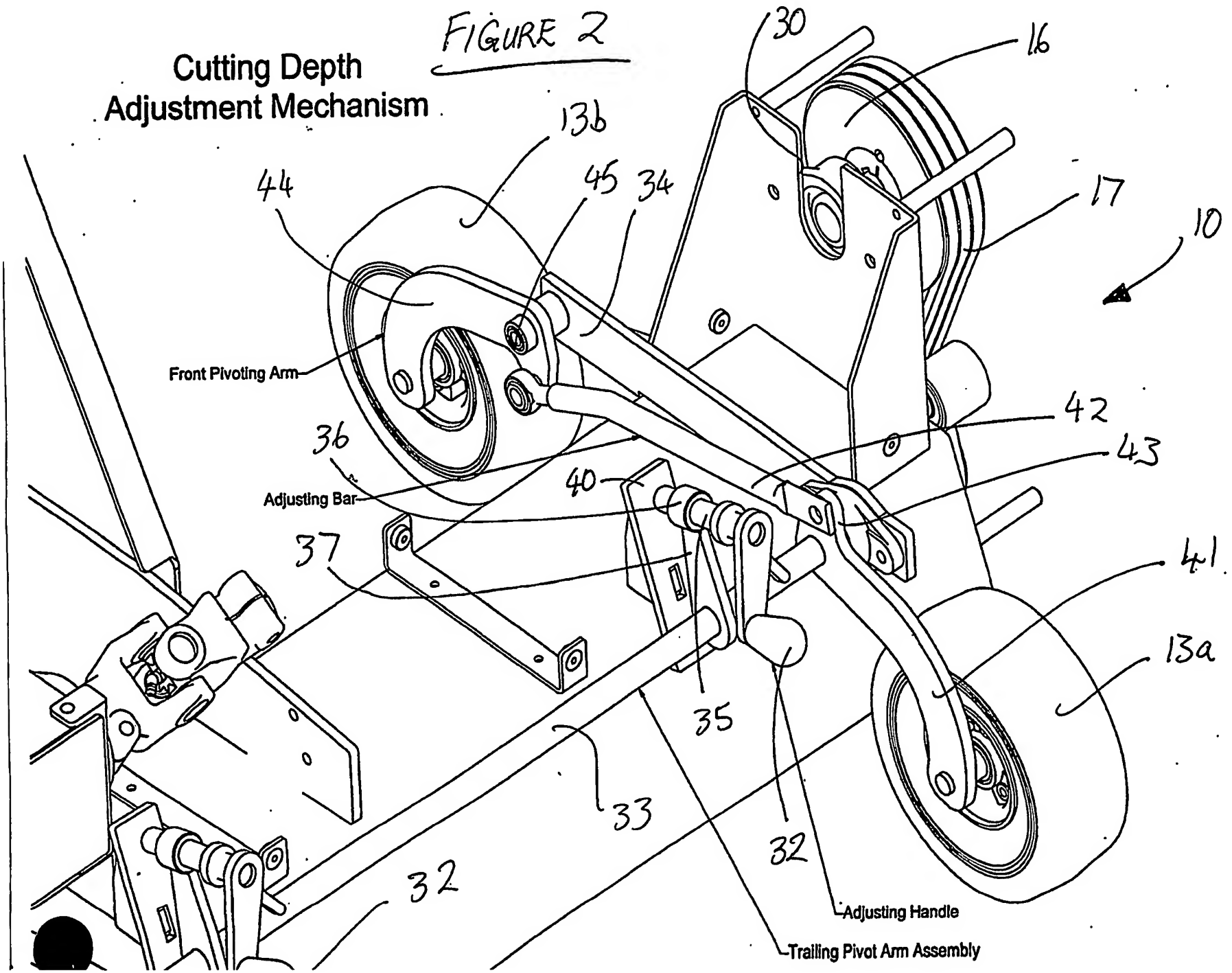


FIGURE 2

Cutting Depth
Adjustment Mechanism



Side View - Rotor Housing Pivot mechanism.
(All extraneous details removed)

FIGURE 3

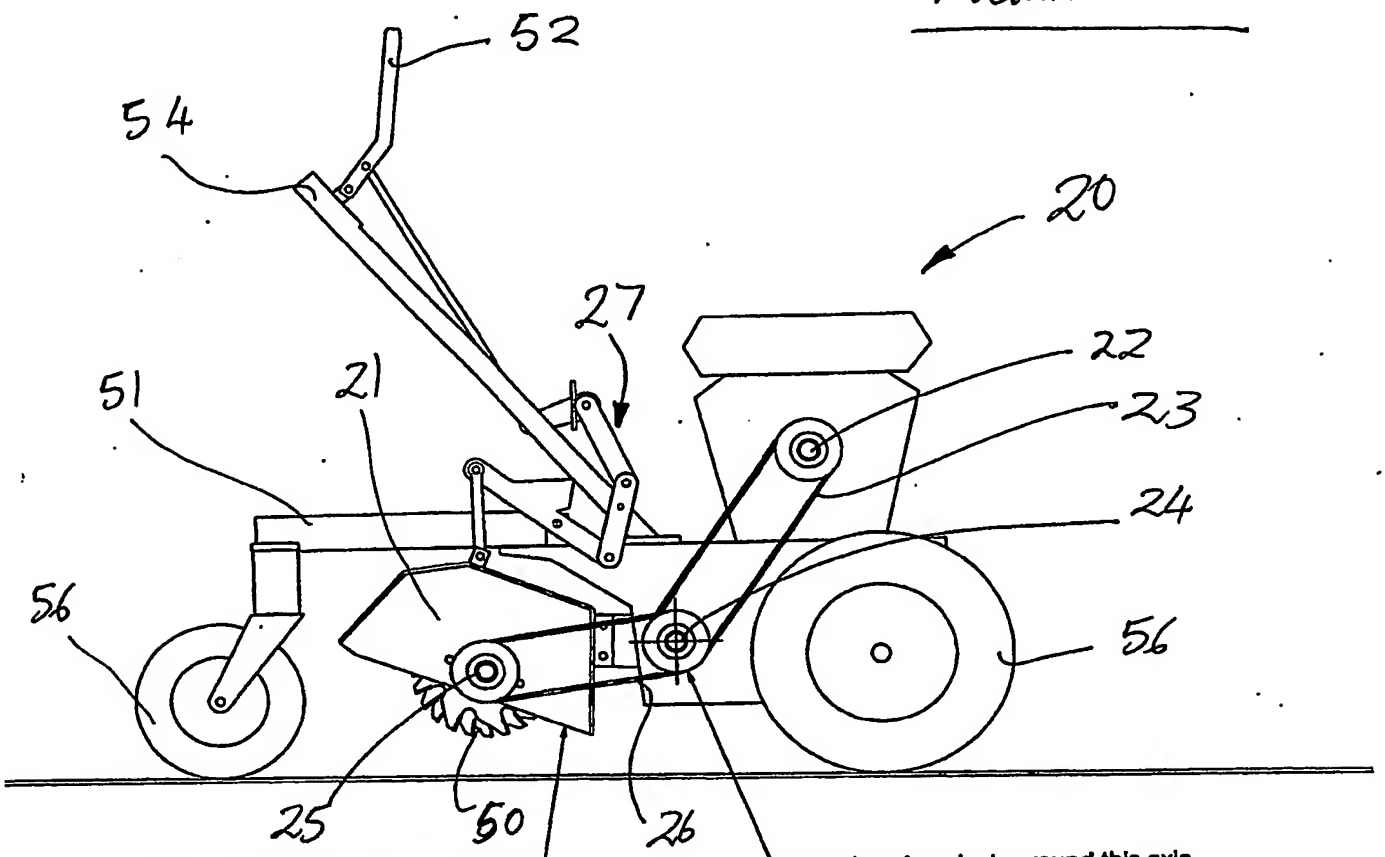
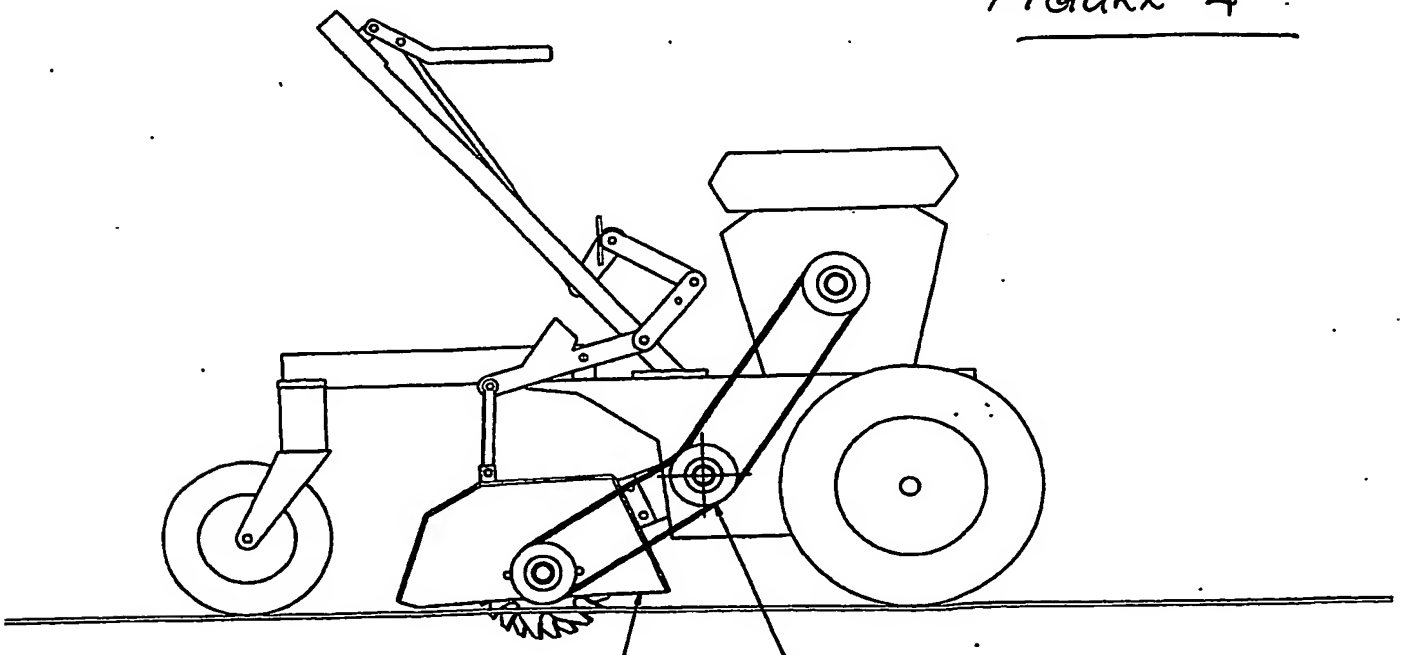
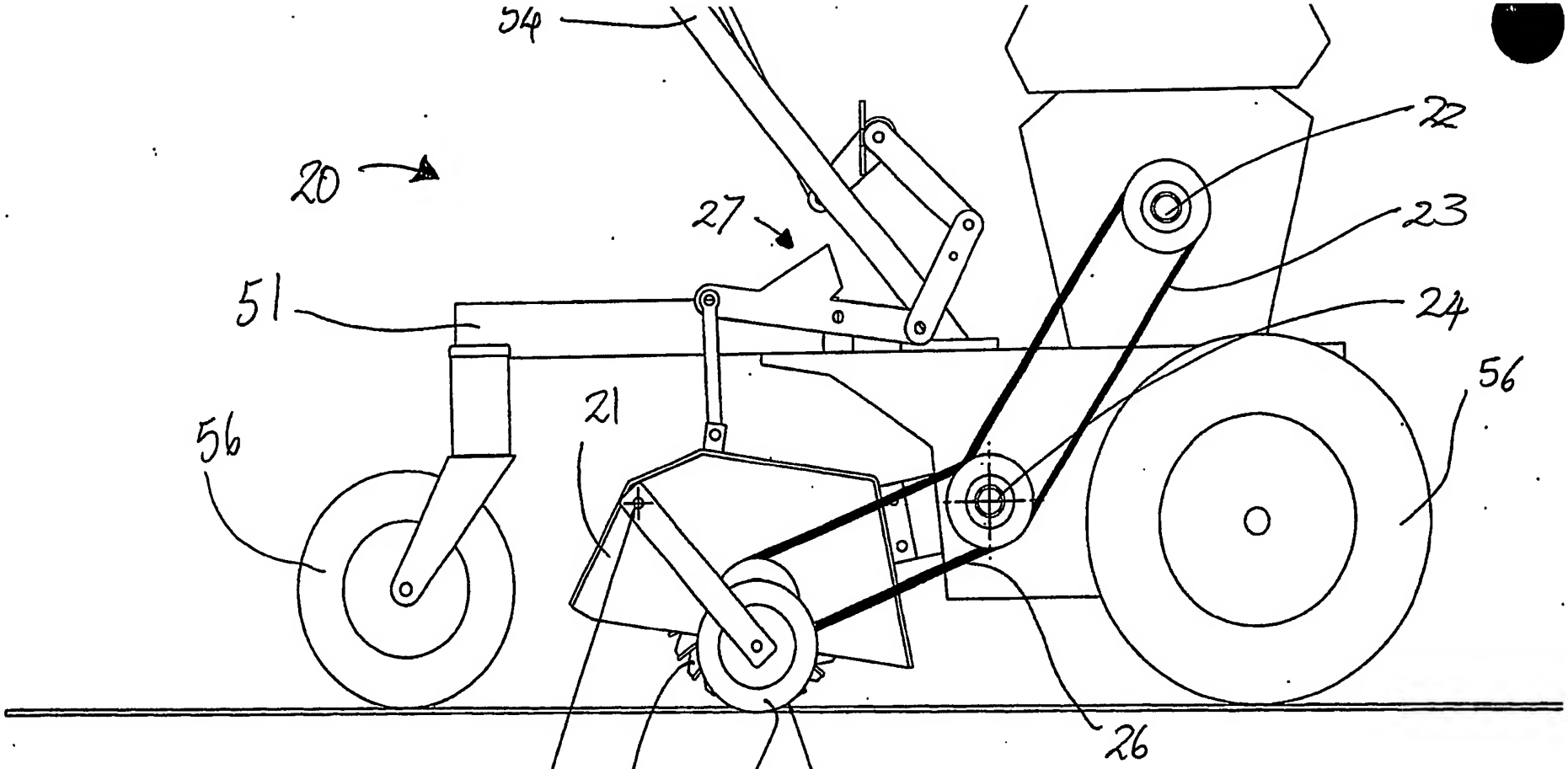


FIGURE 4





Depth wheels pivot around this axis on a mounting arm mechanism. It can be adjusted to different settings to change the cutting depth of the blades, then locked into place.

Depth wheels are in line with the rotor shaft blades. This enables a constant depth of cut, even over undulating surfaces, as complete rotor housing moves with the depth wheel mechanism, matching any undulations in the surface.